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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/975,466	10/09/2001	Auguste J.L. Sophie	ASMMC.036AUS	8303
20995	7590	07/20/2004	EXAMINER	
KNOBBE MARTENS OLSON & BEAR LLP			KIELIN, ERIK J	
2040 MAIN STREET			ART UNIT	
FOURTEENTH FLOOR			PAPER NUMBER	
IRVINE, CA 92614			2813	

DATE MAILED: 07/20/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

**Office Action Summary**

Application No.

09/975,466

Applicant(s)

SOPHIE ET AL.

Examiner

Erik Kielin

Art Unit

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 02 July 2004.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-5, 8-17, 28 and 30-32 is/are pending in the application.
- 4a) Of the above claim(s) none is/are withdrawn from consideration.
- 5) ☒ Claim(s) 6 and 7 is/are allowed.
- 6) ☐ Claim(s) \_\_\_\_\_ is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)  
Paper No(s)/Mail Date \_\_\_\_\_.
- 4) ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date. \_\_\_\_\_.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: \_\_\_\_\_.

## DETAILED ACTION

This action responds to the Amendment filed 19 July 2004.

### *Claim Rejections - 35 USC § 103*

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. Claims 1, 3-5, 8-17, 28, 30 and 32 are rejected under 35 U.S.C. 103(a) as being unpatentable over US Patent Application 2002/0027286 A1 (**Sundararajan et al.**) in view of US 6,143,658 (**Donnelly, Jr. et al.**).

Regarding independent claim 1, **Sundararajan** discloses a process for producing an integrated circuit comprising forming a copper damascene structure **140, 145** on a substrate (Fig. 1A); forming a copper oxide on the copper during CMP (as further limited by instant claim 8); reducing the copper oxide by contacting the oxide with "typically" hydrogen or ammonia plasma --which is a vapor-- (paragraphs [0008] and [0018]), prior to forming a layer comprising silicon carbide, SiC or SiCN (paragraph [0009] and) in the same chamber, wherein the reduction improves the surface for depositing the SiC or SiCN layer, and wherein the layer of SiC or SiCN serves as an etch stop **125** (Fig. 1B; paragraph [0022]).

Regarding independent claim 28, **Sundararajan** discloses a process for producing an integrated circuit comprising the following steps in order,

depositing a copper layer **140, 145** on a substrate (Fig. 1A);

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subjecting the copper layer to a CMP process;  
contacting the substrate with a hydrogen plasma reducing agent (paragraphs [0008]-[0009]); and  
depositing a SiN, SiC, or SiCN etch stop layer (paragraph [0009]), as further limited by instant claims 30 and 32.

**Sundararajan** does not teach that the reductive treatment employs contacting the copper oxide with an organic, vapor phase reducing agent that is not plasma activated.

Further regarding claims 1 and 28 and regarding claims 4 and 5, **Donnelly** teaches that vapor phase reduction of copper oxide using an organic reducing agent, specifically H(hfac) or hydrogen hexafluoroacetylacetone --which is the alcohol form or “enol” form of the  $\beta$ -diketone-- after treatment with a hydrogen plasma to provide better conductivity between wiring line and vias by removal of copper oxide (Donnelly, col. 2, line 57 to col. 3, line 28).

It would have been obvious for one of ordinary skill in the art, at the time of the invention to use the organic, vapor phase reducing agent of **Donnelly** after the hydrogen plasma reduction of **Sundararajan** because **Donnelly** teaches that the organic, vapor phase reducing agent after hydrogen plasma treatment results in better adhesion of the metal layer than with that resulting from a hydrogen plasma (Donnelly, col. 2, line 57 to col. 3, line 28).

Regarding claim 3, an etch stop layer is a hard mask by definition. Even so, it has been held that to be entitled to weight in method claims, the recited structure limitations therein must affect the method in a manipulative sense, and not amount to the mere claiming of a use of a particular structure. See *Ex parte Pfeiffer*, 1962, C.D. 408 (1961). In this case that the SiC layer serves as a stop layer is not manipulative of the method and therefore is not considered to have

patentable weight. Moreover, because the materials are the same in the same damascene structure as shown in Applicant's figures, it is very clear that the SiC serves as a hardmask to every extent as indicated by Applicant.

Regarding claims 9, because the copper is necessarily exposed during CMP and cleaning, the oxide is formed by exposure to "a cleanroom atmosphere."

Regarding claims 10-12 and 14-16, **Sundararajan** discloses the deposition necessarily takes place in a first chamber. The temperature therein is 300 to 450 °C. Further regarding claim 16, although the temperature of about 400 °C is not specifically indicated, the selection of the 400 °C is obvious because it is a matter of determining optimum process condition by routine experimentation with a limited number of species. See *In re Jones*, 162 USPQ 224 (CCPA 1955)(the selection of optimum ranges within prior art general conditions is obvious) and *In re Boesch*, 205 USPQ 215 (CCPA 1980)(discovery of optimum value of result effective variable in a known process is obvious).

Regarding claim 13, that the second chamber is clustered to a first reaction chamber does not have patentable weight because it is not manipulative of the invention. See *Ex parte Pfeiffer*, as above. Nonetheless, cluster tools are known and it would be obvious to one of ordinary skill in the art to use a cluster tool with separate chambers for the separate processes as in a cluster tool, to protect the copper layer from re-oxidation prior to the deposition of the SiC layer, in accordance with the objective in **Sundararajan**.

Regarding claim 17, **Sundararajan** does not disclose the temperature at which the copper is reduced. It would have been obvious for one of ordinary skill in the art, at the time of the invention to use the same temperature for reducing the copper oxide layer as that used for

deposition in order to save time in changing the temperature, and because it would appear that the reduction temperature being equal to the deposition temperature would work just as well as some other temperature.

3. Claims 2 and 31 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Sundararajan** in view of **Donnelly** as applied to claims 1 and 28 above, and further in view of Applicant's admitted prior art (**APA**).

The prior art of **Sundararajan** in view of **Donnelly**, as explained above, discloses each of the claimed features except for indicating that the silicon carbide layer contains oxygen.

**APA** teaches that it is known to use SiC and SiOC as a barrier/etch stop layer. (See instant specification, p. 3, lines 8-10.)

It would have been obvious for one of ordinary skill in the art, at the time of the invention to use silicon carbide with oxygen, because the selection of a know material suitable for an intended purpose is *prima facie* obvious in the absence of unexpected results. Moreover, one of ordinary skill would be motivated to use SiOC because it has a lower dielectric constant than silicon nitride, thereby aiding in the reduction of RC delay which is highly desired in the art.

#### ***Response to Arguments***

4. Applicant's arguments filed 2 July 2004 have been fully considered but they are not persuasive.

Applicant argues that the ordinary meaning of reduction should be used and provides a selective definition not supported by the specification, stating

“As the Examiner points out repeatedly, the definition needs to be interpreted in view of the ordinary, and customary meaning of this term.”

This is **not** what Examiner stated. The Office action cited several examples of case law indicating that the customary meaning of a word was used **unless given a specific definition in the specification**. Applicant's specification provides a specific definition. To repeat from the previous Office action, the instant specification defines “reducing” and “reduction” and “copper layer” at p. 5, as

“As used herein, the terms ‘reduction’ and ‘reducing’ refer to the removal of oxygen atoms from a copper layer. ‘Reduction’ does not have to be complete reduction, and some oxygen atoms may remain in a copper layer after it has been reduced. Thus, a copper layer that is ‘reduced’ or ‘at least partially reduced’ is a copper layer from which some, but not necessarily all oxygen atoms have been removed.”

“The term ‘copper layer’ broadly refers to a layer of copper, a layer of copper oxide or a layer that comprises both copper and copper oxide.”

As can be seen in the excerpt, Applicant's specification provides the definitions of “reduction,” “reducing,” and “copper layer.” Examiner respectfully submits that Applicant cannot now arbitrarily switch definitions to gain patentable distinction. The definitions over which the claims were rejected are based upon Applicant's given definition. There is nothing in the definition of reduction that prohibits removal of copper along with the oxygen. So long as the oxide is removed the “copper layer” has undergone “reduction.” Accordingly, Donnelly, Jr. meets Applicant's own definition of reduction because oxygen is being removed from the copper layer. Accordingly, it is improper for Applicant to forward an argument that directly contradicts Applicant's own admissions on the record.

Applicant continues,

“One of skill in the art will immediately recognize that Applicants are referring to chemical reduction, in view of both the exact correspondence

between Applicant's definition and the dictionary definition and in view of the disclosure in the specification. For example, the specification teaches the 'at least partial reduction of copper oxide to copper' (page 8, lines 11-12, emphasis added). This makes it clear that the oxygen is being removed and copper is being left behind (chemical reduction), and that copper and oxygen are not being removed together. This is further clarified by the statement that the 'CuO layer is reduced by exposure to an organic reducing agent that is capable of removing oxygen from the metal oxide, *leaving elemental copper on the substrate*' (page 8, lines 22-24, emphasis added)."

What one of ordinary skill would immediately recognize does not contradict that defined in the specification for "reduction," "reducing," and "copper layer." Importantly, (1) Applicant has provided no evidence that no copper is being removed, and (2) Donnelly, Jr. leaves behind elemental copper as well; it is the interconnect in Donnelly, Jr. Examiner respectfully submits that Applicant cannot now further change the definition to suit his purposes. Such additional features amounts to introducing new matter.

If Applicant wanted for the terms "reduction" and "reducing" to have their ordinary meaning to one of ordinary skill, why then did Applicant not use these definitions in the specification that Applicant is now trying to argue to re-define the terms "reduction" and "reducing" in the present arguments (at p. 3)? Accordingly, this argument is not found persuasive.

### ***Conclusion***

5. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

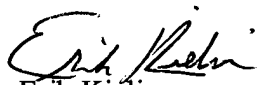


A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Erik Kielin whose telephone number is 571-272-1693. The examiner can normally be reached on 9:00 - 19:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr. can be reached on 571-272-1702. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

  
Erik Kielin  
Primary Examiner  
19 July 2004